perpendicular is manifestly equal to $\surd(\frac{1}{4}e^2 - x^2)$, and as we have evidently—

$$\frac{r}{\surd(\frac{1}{4}e^2 - x^2)} = \frac{e}{2x}, \qquad \text{we obtain} \qquad r = \tfrac{1}{2}h\surd 3.$$

But $h\surd 3$ is a diameter of the hexagonal prism perpendicular to two of its opposite faces; hence a sphere may be inscribed within the cell from a point measured from the vertex at a distance equal to the side of one of the lozenges, and with a radius equal to half the long diagonal of this lozenge, while another sphere with a diameter equal to three times the side of the lozenge circumscribes the triangular pyramid at the summit.

The diameter D′ of the inscribed sphere is equal to the diameter of the cell, while the diameter D of the exterior sphere is equal to the sum of three edges of the pyramid, and it therefore follows from the first note, vol. 41, that between these diameters we have the expression—

$$\frac{\mathrm{D}}{\mathrm{D}'} = \left(\frac{3}{2}\right)^{\frac{3}{2}}.$$

The relation between the geometrical cell and the interior and exterior spheres whose diameters are connected by this equation may possibly have some bearing on the question of the formation of the actual cells.

III. "The Embryology of Monotremata and Marsupialia. Part I." By W. H. Caldwell, M.A., Fellow of Gonville and Caius College, Cambridge. Communicated by Prof. M. Foster, Sec. R.S. Received February 22, 1887.

(Abstract.)*

1. *The Egg-membranes.*

In Monotremata, in very young ova, a fine membrane exists between the single row of follicular cells and the substance of the ovum. This membrane, which I will call *the vitelline membrane*, at first increases in thickness with the growth of the ovum, and through it pass numerous fine protoplasmic processes connecting the protoplasm of the follicular cells with that of the ovum, and serving to conduct food granules, which, appearing in the neighbourhood of the nuclei of the

* The author being at the present time in Australia and so unable to correct the proof of this abstract, I have undertaken this duty. In doing so I have ventured, for the sake of what appeared to be increased clearness, to introduce into § 1 some modifications of the author's manuscript, being guided therein by the author's more detailed account given in the fuller paper.—M. Foster, Sec. R.S.

cells, travel thence to the ovum; food granules also appear in the neighbourhood of the germinal vesicle, and travel away from it: hence the horse-shoe shape of the yolk-mass as seen in section. The time during which food granules are thus passing from the follicular cells to the ovum may be called "the yolk forming period."

It is succeeded by a period during which the vitelline membrane again becomes thin, the follicular cells are reduced to a single layer, and the cells are very thin and flat. This period may be called the "absorption of fluid period," since during it the ovum absorbs large quantities of fluid through the thin vitelline membrane and single layer of thin follicular cells, and thereby increases largely in size.

This is in turn succeeded by a third period, during which the follicular cells again become active, multiply, increase greatly in size, and give rise between themselves and the vitelline membrane to a deeply staining homogeneous layer, which I will call *the chorion*. This period may hence be called "the chorion forming period." All these three periods are gone through while the ovum is still in the follicle.

Upon the bursting of the follicle and the reception of the ovum in the Fallopian tube, a few of the follicular cells remain attached to the chorion; the majority are left behind within the burst follicle.

During the passage along the Fallopian tube, the vitelline membrane again increases in thickness, and the chorion, also increasing in thickness, absorbs fluid and becomes *the albumen layer*. Outside this now appears a new structure, *the shell* or shell-membrane, of tough parchment-like consistency,* not staining with reagents. I have not yet traced the deposition of the shell to the activity of any special glands; but I can say that the shell-membrane does not increase at the expense of the chorion or albumen layer.

After reaching the uterus both vitelline membrane and shell-membrane increase in thickness, but the albumen layer diminishes and disappears, serving apparently for the nutrition of the ovum. Immediately beneath the vitelline membrane a new layer is now seen in hardened preparations; but it may be shown that this layer is really fluid, yielding a coagulum which stains deeply with reagents, the fluid being apparently derived, through the membranes, from the uterine glands.

In Marsupialia the history of the vitelline membrane, save that "the yolk forming period" is not marked off from the "absorption of fluid" period, is similar to that in Monotremata. I have not been able to trace the beginning of the "chorion" while the ovum is still in the

* In the shell of the laid egg of Echidna I have not detected calcic salts, but that of Ornithorhyncus gives rise to gas when treated with dilute acid.

ovary, in Marsupialia; but in an ovum of Phascolarctos, from the uterus, I found a chorion like that of Monotremata, and surrounded moreover by a thin transparent membrane—a *shell-membrane.* Within the uterus the chorion, increasing in thickness, becomes transformed into an albumen layer, and is eventually absorbed, passing through the vitelline membrane to nourish the ovum, so that eventually the vitelline membrane comes to be close to the shell.

As in Monotremata, a coagulable, and, when coagulated, deeply staining fluid makes its appearance between the vitelline membrane and ovum (blastoderm).

The shell-membrane persists until the developing ovum becomes fixed to the walls of the uterus, after which it disappears.

The paper then compares the egg-membranes just described with those of Placentalia, and those of Vertebrata generally.

2. *Segmentation.*

The telolecithal ova of Monotremata and Marsupialia go through a partial segmentation. The ova of Placentalia segment completely, but the resulting blastodermic vesicle is identical with that produced by partial segmentation in Monotremata and Marsupialia.

In Monotremata there is a posterior lip to the blastopore similar to that of Elasmobranchii. The epiblast grows in so rapidly from the sides, that a primitive streak region is formed in front of the posterior lip long before the epiblast has enclosed the yolk. This unenclosed area in front of the primitive streak probably includes a region where the hypoblast (yolk) has secondarily broken through the epiblast. The existence of such a region would hide the position of the anterior lip of the blastopore. The circumference of the circle made up by the larger arc of the edge of the blastoderm on the yolk, and the smaller arc of the posterior lip of the blastopore, is a measure of the quantity of yolk in a meroblastic ovum.

In Marsupialia the epiblastic growth encloses the hypoblast at a very early age, except over a narrow slit in front of the posterior lip of the blastopore. This slit corresponds to the area enclosed by the circle described above in a meroblastic egg. The primitive streak is not conspicuous at an early age because of the large size of the cells. No hypoblast projects through the epiblast in front of the primitive streak region. I would explain the segmentation and the gastrula of Placentalia in the same way. Balfour's objection ('Comp. Embryol,' vol. 2, p. 187) to Van Beneden's original comparison of the blastopore of the rabbit with that of a frog, is explained away by the presence of a posterior lip to the blastopore in Marsupialia. My explanation postulates the existence of a similar structure in the rabbit. The blastopore of the rabbit corresponds therefore to the whole area marked out by the growing epiblast and the posterior lip

of the blastopore before the closing of the primitive streak region, or, to this area minus the secondary extension, caused by the projecting yolk, in Monotremata.

IV. "On the Total Solar Eclipse of August 29, 1886 (Preliminary Account)." By ARTHUR SCHUSTER, Ph.D., F.R.S., Professor of Applied Mathematics in Owens College, Manchester. Received March 3, 1887.

The instrument entrusted to me by the Eclipse Expedition was similar to that employed in Egypt during the eclipse of 1882. The equatoreal stand carried three cameras, one of which was intended for direct photographs of the corona, while the two others were attached to spectroscopes.

Photographs of the Corona.—The lens had an aperture of 4 inches, and a focal length of 5 feet 3 inches; giving images of the moon having a diameter of about 0·6 of an inch.

During the first minute of totality the corona was covered by a cloud, which was, however, sufficiently transparent to allow the brightest parts of the corona to show on the two photographs exposed during that time.

During the remaining time, that is to say, during about two minutes and a half, the sky was clear, but there were clouds in the neighbourhood of the sun.

The time of exposing the photographs, which had been fixed beforehand, had to be altered in consequence of the uncertainty of the weather, and for this reason I can only give the actual times of exposures very approximately and from memory. One photograph on sensitive paper shows only little detail; but three photographs on glass were obtained, which, as regards definition, I believe to be equal to those obtained in Egypt. The approximate exposures were 15 to 20 seconds, 10 to 15 seconds, and about 5 seconds.

With the view of possibly increasing the amount of detail, which it has hitherto been possible to obtain on the photographs of the corona, I have, on this occasion, given considerable attention to the different adjustments, so as to fix the cause which at present limits the definition. A telescope of 4 inches aperture ought to separate two small objects which are at an angular distance of about 6 seconds of arc. The theoretical resolving power can only be realised with small and distinct objects like double stars; in an object like the corona it is difficult to estimate the resolving power actually obtained. Nevertheless, as far as I can judge, the photographs obtained in Egypt and in Grenada with the same instrument show no detail which theoretically could not have been seen with an aperture of 1 inch. The photo-